

PATENT

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/Scott A. Stinebruner/  
Scott A. Stinebruner, Reg. No. 38,323

January 22, 2008  
Date

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

Applicant:	Paul Reuben Day	Art Unit:	2167
Application No.:	10/754,011	Examiner:	Kimberly M. Lovel
Filed:	January 8, 2004		
For:	METHOD APPLYING TRANSITIVE CLOSURE TO GROUP BY AND ORDER BY CLAUSES		

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**RESPONSE AFTER NON-FINAL REJECTION**

Mail Stop Amendment  
Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

Madam:

This paper is submitted in reply to the Office Action dated September 21, 2007 with a one month extension of time. Although this reply is filed on January 22, 2008, the response is within the one month extension of time because January 21, 2008 is a federal holiday, namely, Martin Luther King's birthday. Reconsideration and allowance of all pending claims are respectfully requested.

In the subject Office Action, claims 1, 3-5, 9-10, 13, 15, and 18-24 apparently stand rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 5,875,447 to Goel et al (hereafter Goel) in view of U.S. Patent No. 6,757,677 to Pham et al (hereafter Pham), in further view of U.S. Patent No. 7,191,169 to Tao (hereafter Tao). Furthermore, in the subject Office Action, claims 7-8 and 16-17 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Goel in view of Pham in view of Tao as applied respectively to claims 1 and 13, and further in view of U.S. Patent No. 5,598,559 to Chaudhuri.

Applicants respectfully traverse the Examiner's rejections to the extent that they are maintained. Applicants note that the Examiner's § 103(a) rejections fail to reference U.S. Patent No. 7,191,169 to Tao, but this reference is relied upon in the text of the rejections themselves, so Applicants assume that Tao was intended to be included in the rejection. The rejections also reference claims that have been previously canceled (e.g., claims 6, 11-12 and 14). Thus, Applicants respectfully request that the Examiner notify Applicants if the above summary is inaccurate. Applicants also request that US Patent No 5,960,427 to Goel et al, which was mentioned in the subject Office Action but not relied upon, be added to the notice of references cited. Lastly, Applicants wish to thank the Examiner for withdrawal of the § 101 rejections, and the consideration extended in the telephonic interview conducted between the Examiner and Applicants' representative on July 2, 2007.

Next, turning to the art-based rejections, and more specifically to the rejection of independent claim 1, this claim generally recites a method for optimizing a database query, where the database query includes criteria that references a plurality of tables in order to re-order a result set generated for the database query, where the criteria is one of a GROUP BY clause and an ORDER BY clause. The method includes applying transitive closure analysis to at least one search condition in the query to identify an equivalent field for a field referenced in the criteria, and based on the transitive closure analysis, rewriting the criteria to generate modified criteria to reduce the number of tables referenced thereby by substituting the equivalent field for the field referenced in the criteria, including rewriting the criteria to generate modified criteria that references only one table, based on the transitive closure analysis.

In rejecting claim 1, the Examiner has added to the prior rejection based on Goel and Pham, a new reference to Tao. The Examiner admits that the combination of Goel and Pham does not disclose "...based on the transitive closure analysis, rewriting the criteria to generate modified criteria..." as well as all the other claim limitations not disclosed in Goel or Pham. (Office Action, page 4). The Examiner relies on Tao, and in particular the abstract, col. 7, lines 10-19, col. 8, lines 9-16, and col. 8, lines 43-60, for allegedly disclosing all of the claim limitations not disclosed in Goel or Pham.

As Applicants have noted previously, claim 1 recites in part that transitive closure analysis is applied to a search condition in the query, and is used to identify an equivalent field for a field referenced in the criteria. (Applicants' response dated April 30, 2007, on pages 9-10).

A search condition is described, for example, at page 10, lines 6-9 and page 14, lines 16-21 of the Application, and includes various conditions that are used to search, or select, records from a database table. Transitive closure analysis can be used to analyze these search conditions to identify equivalent search fields. In the example shown at page 14, lines 11-14, for example, transitive closure analysis performed on the search conditions “X.f1=Y.f1” and “Y.f1=Z.f2” is used to determine that field Z.f2 is equivalent to field X.f1.

Claim 1 also recites in part that a criteria, which is either a GROUP BY clause or an ORDER BY clause, may be modified to reduce the number of tables referenced thereby to only one table by substituting an equivalent field for a field referenced in the criteria. In the example shown at page 14, lines 11-14, for example, knowing that field Z.f2 is equivalent to field X.f1 enables the GROUP BY clause “GROUP BY X.f3, Z.f2” to be rewritten as “GROUP BY X.f3, X.f1,” and so that only Table X is referenced in the clause. By doing so, performance can be improved, e.g., by using an index over the table and avoiding the use of a temporary file.

As the Examiner has already admitted, the combination of Goel and Pham does not disclose, for example, “...based on the transitive closure analysis, rewriting the criteria to generate modified criteria...” Tao, however, does not remedy the shortcomings of the combination of Goel and Pham. The passages cited by the Examiner of Tao, as well as other passages, disclose a query classification algorithm used by a query rewriting mechanism. The mechanism “modifies original user queries to reference suitable materialized views instead of the original specified database tables in order to achieve higher performance in processing the queries.” (col. 7, lines 11-19). As such, the queries may be rerouted to reference materialized views that are smaller than the tables referenced in the database query. (col. 3, lines 37-47). Materialized views often have GROUP BY clauses. (co. 3, lines 40-41). However, because creating and maintaining materialized views are often expensive database operations, Tao discloses using the classification algorithm to make recommendations as to which materialized views (e.g., a materialized view that can be utilized by many queries) to create. (abstract). Specifically, Tao classifies queries in terms of anchor join graphs, full query join graphs, and grouping conditions, among other features, and collects statistics on the classifications. (col. 5, lines 41-67, col. 7, lines 20-26, col. 9, lines 60-63).

With respect to the anchor join graphs, Tao discloses computing the transitive closure of all equivalent predicates to avoid falsely introducing new anchor join graph classification when

comparing anchor join graph structures. (col. 8, lines 9-12). Queries can be classified under the same anchor join graph when the transitive closure of their anchor join graph structures are identical. (col. 8, lines 12-18).

However, Applicants have not found any disclosure in Tao of rewriting a criteria such as a GROUP BY or ORDER BY clause that re-orders a result set based upon transitive closure analysis to reduce the number of tables referenced by the criteria, or doing so by substituting equivalent fields for fields identified in a GROUP BY or ORDER BY clause in order to reduce the number of tables referenced by such a clause. Therefore, Tao does not disclose all of the limitations of claim 1 that the Examiner acknowledges are likewise not disclosed by Goel and/or Pham, and thus the proposed combination falls short of teaching each and every limitation of claim 1.

Notably, (1) any transitive closure analysis in Tao appears to be directed towards classifying queries (col. 8, lines 43-44), not for identifying an equivalent field for a field referenced in a criteria, and (2) the only rewriting that Applicants have found is the rewriting of queries to reroute execution to a smaller materialized view instead of a larger base table. (col. 7, lines 11-19). With respect to the latter, it appears that Tao simply reroutes the query to access the persistently stored data of the materialized view, and this has nothing to do with rewriting the criteria of a query to reduce the number of tables that are referenced or in accordance with the other claim limitations. (col. 3, lines 21-24). Given that materialized views are arguably tables themselves, the queries in Tao appear to be simply rewritten to replace the original tables with other tables (i.e., the materialized views), after suitable materialized views have been recommended and created, and Tao does not appear to disclose or suggest anything more than changing the name of the table that will be accessed during the query's execution. The number of tables is not reduced, instead one table is replaced by another table, leaving the total number of tables the same. In particular, statement 2 in the background of Tao defines the view that may be created from statement 1, and all three tables referenced in statement 1 are illustrated as statement 2; thus, Applicants do not see any indication in Tao that rerouting to a materialized view will reduce the number of tables in referenced as in claim 1. Plus, even if the number of tables is reduced, which Applicants argue is not the case, it is not reduced by substituting fields. Furthermore, the transitive closure in Tao is for classification not for rewriting or rerouting to a

materialized view. Tao also does not disclose or suggest rewriting the query behind the materialized view, or any GROUP BY clauses therein.

Tao also does not disclose or suggest, “modified criteria that references only one table” as recited in claim 1. Although the background of Tao indicates that reusing a materialized view with groupings to answer different queries is a transitive relationship, even this example, shows more than one table. (col. 4, lines 36-53). Moreover, Tao does not disclose or suggest re-ordering a result set.

While Goel, Pham, and Tao generally attempt to optimize queries with GROUP BY clauses, none of the references, alone or in combination, disclose or suggest rewriting a GROUP BY clause, or any other criteria that re-orders a result set, to reduce the number of tables referenced by that criteria. Moreover, none of the references discloses or suggests doing so through the use of transitive closure analysis, or through the substitution of a field in a GROUP BY clause with an equivalent field as determined by applying transitive closure analysis to a search condition in a query. Indeed, Applicants cannot even find any disclosure in the references directed to rewriting any criteria that re-orders a result set. Moreover, Applicants respectfully submit that the more references the Examiner relies on for her §103 argument, the less likely it is that Applicants’ invention is obvious.

Applicants accordingly submit that the combination proposed by the Examiner does not disclose or suggest each and every limitation of claim 1, so the rejection of claim 1 should be withdrawn. Reconsideration and allowance of claim 1, and of claims 3-5 and 7-9 which depend therefrom, are therefore respectfully requested.

Next, turning to the rejection of independent claim 10, this claim as amended generally recites a method of optimizing a database query, where the database query includes criteria that operates to re-order a result set of the database query and requires creating a temporary file during operation, and where the criteria is one of a GROUP BY clause and an ORDER BY clause. The method includes applying transitive closure analysis to at least one search condition in the query to identify an equivalent field for a field referenced in the criteria, and rewriting the criteria, based on the transitive closure analysis, to generate a modified criteria by substituting the equivalent field for the field referenced in the criteria. The criteria references a plurality of tables and the modified criteria references a single table, and the modified criteria operates to re-order a result set of the database query and avoid creating a temporary file during operation.

In rejecting claim 10, the Examiner again relies on the combination of Goel, Pham, and Tao, and cites the same passages of Tao from claim 1. As with claim 1, however, none of the references, alone or in combination, disclose or suggest all the features recited in claim 10. Notably, Applicants have not found any disclosure in the references applying transitive closure analysis to rewrite a GROUP BY clause, or any other criteria that re-orders a result set, to reduce the number of tables referenced by that criteria, or to avoid the creation of a temporary file during operation. Similar, the references do not apply transitive closure analysis for the purpose of identifying an equivalent field for a field, and substituting an equivalent field for a field identified in a GROUP BY or ORDER BY clause as recited by claim 10.

Turning specifically to Tao, although the Examiner is encouraged to review pages 12-13 in Applicants' response dated April 30, 2007 regarding Goel and Pham with respect to claim 10, Tao does not remedy the shortcomings of Goel and Pham. The Examiner cites Tao for allegedly disclosing identifying an equivalent field for a field referenced in the criteria, and rewriting the criteria, based on the transitive closure analysis, to generate modified criteria, wherein the criteria references a plurality of tables and modified criteria references a single table. However, Applicants cannot find any disclosure in Tao wherein the criteria references a plurality of tables and modified criteria references a single table as alleged by the Examiner. While Goel, Pham, and Tao generally attempt to optimize queries with GROUP BY clauses, none of the references, alone or in combination, discloses or suggests rewriting a GROUP BY clause (e.g., to reference a single table), or any other criteria that re-orders a result set, to avoid the creation of a temporary file. Furthermore, Applicants respectfully note that because Tao replaces an actual table with a materialized view, and materialized views are often thought of as temporary tables, Tao teaches away from avoiding the creation of temporary tables. Instead, Tao encourages the creation of temporary tables by recommending the creation of materialized views, the opposite of avoiding the creation of a temporary file.

Moreover, no reference discloses or suggests doing so through the use of transitive closure analysis performed on a search condition in a query and used to identify an equivalent field that can be substituted for a field in the clause. Applicants accordingly submit that the combination proposed by the Examiner does not disclose or suggest each and every limitation of claim 10, so the rejection of claim 10 should be withdrawn. Reconsideration and allowance of claim 10 are therefore respectfully requested.

Next, with regard to the Examiner's rejection of independent claim 13, this claim generally recites a method for optimizing a database query, where the database query involves a plurality of join operations and a plurality of search conditions. The method includes applying transitive closure analysis to the plurality of search conditions in the query to determine a subset of equivalent search fields, rewriting a criteria, that operates to re-order a result set of the database query, to generate a set of respective modified criteria that each reference one or more equivalent search fields, where the criteria is one of a GROUP BY clause and an ORDER BY clause, and selecting a join order from among a plurality of join orders for the plurality of join operations, including analyzing join orders using at least one of the set of respective modified criteria.

In rejecting claim 13, the Examiner again relies on the combination of Goel, Pham, and Tao, and cites the same passages from Tao. At nowhere in any of the cited passages of these references, however, is there any discussion or suggestion of selecting a join order from among a plurality of join orders, including analyzing join orders using at least one of the set of modified criteria. Tao simply discloses using and recommending materialized views, which may have joins, but Applicants cannot find any disclosure about selecting a join order, etc. as recited in claim 13. Likewise, Tao simply discloses queries, which may have joins, but Applicants cannot find any disclosure about selecting a join order, etc. as recited in claim 13.

As discussed at page 16 of the Application, join orders are typically locked to start with a particular table whenever a GROUP BY or ORDER BY clause is present that references the table and is implemented by an index. As such, the number of potential join orders that may be tried during optimization may be constrained. By replacing fields in a GROUP BY or ORDER BY clause with equivalent fields as determined through transitive closure analysis, additional join orders may be tried, leading to the potential for finding a more optimal query implementation. Tao merely mentions joins, but neither Goel, Pham, nor Tao appreciate this feature, nor that a set of modified criteria may be generated to enable different join orders to be analyzed.

Moreover, none of the three references, alone or in combination, disclose rewriting a criteria that operates to re-order a result set, much less doing so to generate a set of modified criteria that each reference one or more equivalent search fields, as required by claim 13. The cited passages of Tao discuss the use of group-by operators for classification of queries;

however, Applicants can find no reference to modifying a criteria in a query that re-orders a result set. In addition, Applicants can find no reference to rewriting any portion of a query to reference equivalent search fields based upon transitive closure analysis that determines equivalent search fields. The disclosure in Tao of rewriting the original query to reference suitable materialized views is not based on transitive closure, and the transitive closure that is mentioned is for anchor join graph classification.

Accordingly, Applicants submit that claim 13 is non-obvious over Goel, Pham, and Tao. Reconsideration and allowance of claim 13, and of claims 15-19 which depend therefrom, are therefore respectfully requested.

Next, with respect to independent claims 20 and 24, these claims have claim limitations similar to claim 1, and as such, are patentable over Goel, Pham, and Tao for the same reasons as claim 1. Likewise, claim 22 is similar to claim 13, and as such, this claim is patentable over Goel, Pham, and Tao for the same reasons as claim 13. Reconsideration and allowance of claims 20, 22 and 24, and of claims 21 and 23 which depend therefrom, are therefore respectfully requested.

As a final matter, Applicants traverse the Examiner's rejections of the dependent claims based upon their dependency on the aforementioned independent claims. In particular, claims 7-8 and 16-17 are nonobvious despite the additional Chaudhuri references for the reasons discussed above in connection with independent claims 1 and 13. Nonetheless, Applicants note that a number of these claims recite additional features that further distinguish these claims from the references cited by the Examiner.

For instance, claim 4 additionally recites rewriting the criteria to reference the first field and a third field from the first table, and a first search condition in a query searches on a match between a first field and a second field, and a second search condition in the query searches on a match between the second field and a third field. The claim also recites applying transitive closure analysis includes determining that the third field is equivalent to the second field in the criteria. While Applicants submit that Tao does not disclose rewriting the criteria to generate modified criteria based upon transitive closure analysis as described hereinabove, even if Tao did rewrite criteria, Tao does not disclose rewriting, matching and applying transitive closure as indicated in claim 4.



Claim 9 additionally recites running the query according to a join order that is based on the modified criteria. While Applicants submit that Tao does not disclose generating modified criteria, even if Tao did, Tao does not disclose running the query according to a join order that is based on the modified criteria.

Claim 15 additionally recites running the query according to a join order that is determined by selecting one of the set of respective modified criteria. While Applicants submit that Tao does not disclose generating modified criteria, even if Tao did, Tao does not disclose running the query according to the join order that is determined by selecting one of the set of respective modified criteria.

Claim 19 additionally recites performing cost analysis on each of the set of respective modified criteria, and running the query according to a join order determined based on the cost analysis. While Applicants submit that Tao does not disclose generating modified criteria, even if Tao did, Tao does not disclose performing cost analysis on each of the set of respective modified criteria, and running the query according to a join order determined based on the cost analysis.

In summary, Applicant respectfully submits that all pending claims are novel and non-obvious over the prior art of record. Reconsideration and allowance of all pending claims are therefore respectfully requested. If the Examiner has any questions regarding the foregoing, or which might otherwise further this case onto allowance, the Examiner may contact the undersigned at (513) 241-2324. Moreover, if any other charges or credits are necessary to complete this communication, please apply them to Deposit Account 23 3000.

Respectfully submitted,

January 22, 2008

Date

/Scott A. Stinebruner/

Scott A. Stinebruner  
Reg. No. 38,323  
WOOD, HERRON & EVANS, L.L.P.  
2700 Carew Tower  
441 Vine Street  
Cincinnati, Ohio 45202  
Telephone: (513) 241-2324  
Facsimile: (513) 241-6234